Improved Bayesian Posterior Probability Estimates with Neural Networks in Speech Recognition

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Abstract

Neural networks can be used as **Bayesian posterior probability** estimators in speech recognition system when we have arbitrarily large amount of training data and arbitrarily complex networks that are perfectly trained. However, in practice, these assumptions are not satified and therefore affect system's performance negatively. We use empirical estimates based on histograms to measure how good neural network probability estimates are for each class. The deviations shown by histograms confirm that neural networks fall short of being ideal estimators. We address this problem and propose a new method by selecting well-trained classes and

remapping their neural network outputs based on the histograms to match the data and thereby improve the estimates of posterior probabilities. Experiments on OGI Census Year corpus resulted in a 27% reduction at sentence-level error (from 6.3% to 4.6%); experiments on OGI Digit corpus resulted in a 25.4% reduction at word-level error (from 6.03% to 4.5%) and 20.8% reduction at sentence-level error (from 19.80% to 15.68%), with negligible amount of parameters added for remapping and negligible calculation used for remapping. The results of McNemar's test showed the statistical significance of this new approach.

Neural network outputs may fail to estimate posterior probabilities well especially for infrequent classes that are short of training samples. Because remapping as a post-processing depends on neural networks, we need to improve neural networks as **posterior probability** estimators fundamentally. My ongoing work towards Ph.D. thesis includes: (1).Improving neural networks as **posterior probability** estimators by developing new activity functions or new cost functions;(2).Studying speech features to develop speech-recognition-oriented neural networks;(3).Simulations on artificial data (toy problems) to study the mechnism of current neural networks as **Bayesian posterior probability** estimators under a controllable environment and to develop new neural network models. Preliminary work has been done in these areas, with promising theoretical and experimental results

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